Claims

[c1]   1.A variable gain amplifier, comprising:

an amplifying stage for generating an output voltage according to a differential input voltage; and

a gain controlling stage for outputting a gain controlling voltage to determine a voltage gain of the amplifying stage according to a first controlling voltage and a second controlling voltage, such that the voltage gain is inversely proportional to a simple exponential function, the value of the simple exponential function being determined by the difference between the first controlling voltage and the second controlling voltage.

[c2]   2.The variable gain amplifier of claim 1, wherein the denominator of the voltage gain of the amplifying stage can be expressed as $(K1+\exp(K2 \times Vy))$, both K1 and K2 are substantially constants, and Vy is the gain controlling voltage.

[c3]   3.The variable gain amplifier of claim 2, wherein the gain controlling voltage can be expressed in the form of the difference of the first and the second controlling voltages.

[c4]   4.The variable gain amplifier of claim 1, wherein the gain controlling stage comprises:

a transconductance unit for generating a first current and a second current according to the first controlling voltage and the second controlling voltage, wherein the ratio between the first current and the second current is determined by the difference between the first controlling voltage and the second controlling voltage;

a current transforming unit coupled to the transconductance unit for generating a third current corresponding to the first current, and a fourth current corresponding to the second current; and

an outputting unit coupled to the current transforming unit for generating the gain controlling voltage according to the third current and the fourth current;

wherein the value of the gain controlling voltage is determined by the difference between the first controlling voltage and the second controlling voltage.

[c5]   5.The variable gain amplifier of claim 4, wherein the relationship between the first current, the second current, the first controlling voltage, and the second controlling voltage is: $I1 / I2 = \exp(K \times (V1-V2))$; where $I1$ is the first current, $I2$ is the second current, $V1$ is the first controlling voltage, and $V2$ is the second controlling voltage.

[c6]   6. The variable gain amplifier of claim 5, wherein the value of the third current is substantially the same as that of the first current, and the value of the fourth current is substantially the same as that of the second current.

[c7]   7. The variable gain amplifier of claim 5, wherein the gain controlling voltage is proportional to $\ln(I1/I2-K3)$ and $K3$ is a constant.

[c8]   8. The variable gain amplifier of claim 4, wherein the transconductance unit comprises:
a first transistor coupled to the first controlling voltage;
a second transistor coupled to the second controlling voltage; and
a first bias current source coupled to the first transistor and the second transistor for providing a first bias current;
wherein the first transistor outputs the first current according to the first controlling voltage and the first bias current, and the second transistor outputs the second current according to the second controlling voltage and the first bias current.

[c9]   9. The variable gain amplifier of claim 4, wherein the outputting unit comprises:
a third transistor , wherein the current of the third tran-

sistor corresponds to the fourth current;

a fourth transistor; and

a second bias current source coupled to the third transistor and the fourth transistor for providing a second bias current, wherein the second bias current corresponds to the third current;

wherein the third transistor and the fourth transistor are for outputting the gain controlling voltage.

[c10] 10.The variable gain amplifier of claim 9, wherein the value of the second bias current is substantially the same as the value of the third current, and the value of the current of the third transistor is substantially the same as the value of the fourth current.

[c11] 11.The variable gain amplifier of claim 4, wherein the current transforming unit comprises a current mirror circuit.

[c12] 12.The variable gain amplifier of claim 4, wherein the current transforming unit comprises:

a first current transforming unit, comprising:

a fifth transistor having a first end being coupled to a second end;

a sixth transistor;

a third bias current source coupled to a third end of the fifth transistor and the sixth transistor for providing a

third bias current; and

a fourth current source coupled to the fifth transistor and the transconductance unit; and

a second current transforming unit comprising:

a seventh transistor having a first end and a second end being coupled to the sixth transistor for outputting the third current;

an eighth transistor coupled to the fifth transistor for outputting the fourth current; and

a fourth bias current source coupled to the seventh transistor and the eighth transistor for providing a fourth bias current.